CLAIMS

1. An apparatus for creating a pattern on a workpiece sensitive to light radiation, such as a photomask a display panel or a microoptical device, comprising

a source for emitting light in the wavelength range from EUV to IR,

a spatial light modulator (SLM) having a multitude of modulating elements (pixels), adapted to being illuminated by said radiation

a projection system creating an image of the modulator on the workpiece,

an electronic data processing and delivery system receiving a digital description of the pattern to be written, converting said pattern to modulator signals, and feeding said signals to the modulator,

a precision mechanical system for positioning said workpiece and/or projection system relative to each other

an electronic control system controlling the position of the workpiece, the feeding of the signals to the modulator and the intensity of the radiation, so that said pattern is printed on the workpiece

where the drive signals and the modulating elements are adapted to create a number of modulation states larger than two and preferably larger than three.

2. An apparatus according to claim 1, where a modulating element modulates at least one of the following properties of the radiation:

- intensity
- phase
- complex amplitude
- direction
- polarisation
- wavefront flatness
- frequency

where the modulation impressed on the radiation field has at least three, and preferably at least four, different states.

3. An apparatus according to claim 2, having a filter selective to the state of the radiation, thereby translating the modulation across the surface of the spatial modulator to an intensity image at the workpiece.

4. An apparatus according to claim 1, where a compensating linearisation function is used in the conversion from the input pattern description to the modulator voltages to correct for a non-linear response from the modulator voltages to the exposure on the workpiece.

5. An apparatus according to claim 4, where the linearization function is based on a theoretical simulation.

6. An apparatus according to claim 4, where the linearization function is based on an empirical characterisation of the response.

7. An apparatus according to claim 4, where said response is the physical or chemical result of the exposure of a surface element, such as the light absorbtion of a developed silver halide emulsion, or the removal of material mass per surface area by an ablation process.

8. An apparatus according to claim 4, where the desired responses are computed as digital values and the linearisation function is stored in a look-up table generating new corrected digital values used for generation of the modulator drive voltages.

9. An apparatus according to claim 8, where the modulator voltages are created by digital analog converters.

10. An apparatus according to claim 4, where the desired responses are computed as digital values and the values are used to select for each modulating element one

of several inpendently generated voltages, and where said voltages are set to contain the linearisation function.

11. An apparatus according to ~~any of the preceding claims~~ claim 1, where at least two modulator voltage signals are fed to a single modulator element and the modulator element is responsive to the combination of the signals, thereby being driven to a larger number of states than the number of possible voltage values in each signal, e.g. four binary signals creating sexteen different states of the modulating element.

12. An apparatus according to ~~any of the previous claims~~ claim 1, with a look-up table with corrections for different response between modulator elements.

13. An apparatus according to claim 12, where the look-up table is generated during a calibration procedure where the response function of at least two different modulator elements are measured.

14. An apparatus according to claim 12, where said look-up table storing at least one of the following types of data for a modulating element:

- An offset voltage
- A sensitivity factor
- A polynomial response function.

15. An apparatus according to claim 12, where the correction of a modulating element is applied as a digital operation on a digital representation of the desired state of the modulator element.

16. An apparatus according to claim 12, where the correction of a modulating element is applied by an analog operation on the analog drive signal.

17. An apparatus according to ~~any of the claims 1-16~~ claim 1, where the spatial modulator is a two-dimensional array of modulating elements with time-multiplexed loading of the values to the modulating elements and storage of the loaded value at each element.

18. An apparatus according to claim 1 ~~any of the claims 1-16~~, where the modulator is built on a matrix-addressed active circuit

19. An apparatus according to claim 1 ~~any of the claims 1-16~~, where the modulator is built on top of a semiconductor chip.

20. An apparatus according to claim 1 ~~any of the claims 1-16~~, where the modulator contains a licuid crystal.

21. An apparatus according to claim 1 ~~any of the claims 1-16~~, where the modulator has a viscoelastic layer.

22. An apparatus according to claim 1 ~~any of the claims 1-16~~, where the modulator has an array of micromechanical elements, and preferably an array of micromirrors, and most preferably an array of pyramidal micromirrors.

23. An apparatus according to claim 1 ~~any of the preceding claims~~, where the modulator is reflective.

24. An apparatus according to claim 1 ~~any of the claims 1-22~~, where the modulator is transmissive.

25. An apparatus according to claim 1 ~~any of the preceding claims~~, where the input pattern is decomposed into a number of exposure fields, and said exposure fields are exposed at different positions on the workpiece, thereby stitching together the complete pattern from said exposure fields.

26. An apparatus according to claim 25, where the stage and projection system are adapted to making strokes of continuous travel relative to each other, and the electronic control system coordinates the motion, the loading of the modulator drive signals and the illumination, in such a way that at least two, and preferably at least ten, exposure fields are exposed during an uninterrupted stroke.

27. An apparatus according to claim 1 ~~any of the preceding claims~~, further comprising a timing unit controlling the timing of the emission of radiation from the light source.

28. An apparatus according to claim 27, whereby the timing unit predicts the time delay for a control signal to the light source emission according to the previous measurements, and compensates for the same.

29. An apparatus according to ~~any of the preceding claims~~ claim 1, whereby the light source is a laser, and preferably an excimer laser.

30. An apparatus according to ~~any of the preceding claims~~ claim 1, where the illumination of at least one modulating element of the SLM is pulsed, and preferably the illumination of the entire SLM.

31. An apparatus according to claim 30, where the pulse length (full width half maximum or equivalent) of the illumination of a modulating element of the SLM is shorter than the time to travel a distance corresponding to three pixels projected on the workpiece.

32. An apparatus according to ~~any of the claims 1-29~~ claim 1, where the illumination of at least one modulating element of the SLMis continuos and scanned, and preferably the illumination of the entire SLM.

33. An apparatus according to ~~any of the preceding claims~~ claim 1, where the digital description of the pattern is in a symbolic format, e.g. a vector or algorithmic format.

34. An apparatus according to claim 25 ~~or 26~~, where the stage and/or optical system is adapted to producing a microlithographic pattern with features smaller than 30 μm and/or placement and size accuracy better than 3 μm (3 sigma).

35. An apparatus according to ~~any of the preceding claims~~ claim 1, where the pattern is formed in photoresist, photopolymer or photographic emulsion.

36. An apparatus according to ~~any of the preceding claims~~ claim 1, where the pattern is formed by ablation, a photorefractive effect, a photochemical alteration of a component of the workpiece or by a thermal process.

37. An apparatus according to claim 1, where the electronic data processing system has an array of parallel processors for real-time pattern conversion.